Mg and Fe isotopes in primitive Icelandic olivine – what do they reveal?

M. B. RASMUSSEN*[1], H. M. WILLIAMS[2], E. T. TIPPER[2], S. A. HALLDÓRSSON[1]

[1] Nordic Volcanological Center, University of Iceland, Reykjavik, Iceland (*maja@hi.is)
[2] University of Cambridge, Cambridge, UK

Geochemical variations captured in Icelandic basalts have primarily been credited to the tapping of a heterogenous plume constituting both primodial and recycled components. Within the framework of such high-temperature igneous systems a change in source lithology, melt oxidation state and incorporation of recycled crust is expected to cause subtle variations in stable isotopic systems such as Fe and Mg. Olivine is usually the first mineral to precipitate out of a mantle-derived melt making it an ideal proxy for primary melt- and source composition. As Fe and Mg are major constituents in olivine, any source-controlled isotopic variations are expected to be reflected in their isotopic composition.

We present a study in which we couple single grain and bulk measurements of Fe and Mg isotopic analysis in a set of well-studied olivines from Iceland's neo-volcanic zones as well as Tertiary lavas. Here we observe variations in δ^{56}Fe between -0.31 and 0.14 ‰, clearly resolvable from the expected average MORB value of 0.11± 0.01 ‰ [1] and previous publised values for Iceland, whereas most of the δ^{26}Mg isotopic values are unresolvable from the expected MORB values of -0.25 ± 0.06 ‰ [2]. Neither Fe nor Mg isotopes display any correlation with Mg-content (Fo content) suggesting that the isotopic variations are independent of magmatic differentiation processes.

Kinetic diffusion has been known to affect olivine δ^{56}Fe and δ^{26}Mg and typically generates a negative correlation between δ^{56}Fe and δ^{26}Mg. However, no such correlation is observed, suggesting that diffusion cannot explain the full range of δ^{56}Fe variation. Other processes, such as incorporation of pyroxenite-derived melts, may be involved. However, no clear correlation is observed between olivine minor and trace elemental ratios indicative of pyroxenitic melt interaction and δ^{56}Fe, suggesting the need for further evaluation of the controls on isotopic fractionation in high-temperature magmatic systems and partitioning into magmatic olivine.

[1] Teng *et al.*, (2013), *GCA* **107**, 12-26; [2] Stracke *et al.*, (2018), *GCA* **226**, 192-205